

Claims

[c1] What is claimed is:

1.A regulated charge pump comprising:

a negative charge pump for generating a first output voltage by determining an oscillation signal; and

a regulator for restricting a swing of the first output voltage, the regulator comprising:

a level shift circuit connected to the negative charge pump for generating a second output voltage at an output end of the level shift circuit by determining the first output voltage generated by the negative charge pump, the level shift circuit comprising:

a plurality of serially connected PMOS transistors, a first source of a first PMOS transistor of the PMOS transistors connected to a first reference voltage source, a first gate and a first drain of the first PMOS transistor connected to the output end of the level shift circuit, and a second gate and a second drain of a second PMOS transistor of the PMOS transistors connected to the output end of the negative charge pump;

a differential amplifier, whose first and second input ends are connected to a second reference voltage source and the output end of the level shift circuit respectively,

for generating a compare signal by determining a voltage difference between the second output voltage and a voltage generated by the second voltage source; and a voltage-controlled oscillator connected between an output end of the differential amplifier and an input end of the negative charge pump.

[c2] 2.The regulated charge pump of claim 1, wherein the second voltage source is ground.

[c3] 3.The regulated charge pump of claim 1 further comprising:
a protection circuit, whose input end and output end are connected to the output end of the negative charge pump and wells of the PMOS transistors respectively, for generating a first protection voltage at the output end of the protection circuit by determining the first output voltage.

[c4] 4.The regulated charge pump of claim 3, wherein the protection circuit comprises:
a switch, whose first and second ends are connected to the output end of the protection circuit and the first protection voltage respectively; and
a voltage detection circuit connected to the switch and to the output end of the negative charge pump for controlling the switch by determining the first output voltage.

- [c5] 5.The regulated charge pump of claim 4, wherein when the voltage detection circuit detects that the first output voltage is lower than a threshold voltage, the switch is closed and transmits the first protection voltage to the wells of the PMOS transistors.
- [c6] 6.The regulated charge pump of claim 1 further comprising:
a protection circuit, whose input end, first, and second output ends are connected to the output end of the negative charge pump, a first well of the first PMOS transistor, and wells of remaining PMOS transistors respectively, for generating first and second protection voltages at first and second output ends of the protection circuit respectively by determining the first output voltage.
- [c7] 7.The regulated charge pump of claim 6, wherein the first protection voltage is higher than the second protection voltage.
- [c8] 8.The regulated charge pump of claim 6, wherein the protection circuit comprises:
a switch, whose first, second, third, and fourth ends are connected to a first output end of the protection circuit, the first protection voltage, a second output end of the

protection circuit, and the second protection voltage respectively; and

a voltage detection circuit connected to the switch and to the output end of the negative charge pump for controlling the switch by determining the first output voltage.

[c9] 9.The regulated charge pump of claim 8, wherein when the voltage detection circuit detects that the first output voltage is lower than a threshold voltage, the switch is closed and transmits the first and second protection voltages to the first well of the first PMOS transistor and the wells of the remaining PMOS transistors respectively.

[c10] 10.A regulated charge pumping comprising:
a negative charge pump for generating a first output voltage by determining an oscillation signal; and
a regulator for restricting a swing of the first output voltage, the regulator comprising:
a level shift circuit connected to the negative charge pump for generating a second output voltage at an output end of the level shift circuit by determining the first output voltage generated by the negative charge pump, the level shift circuit comprising:
a plurality of serially connected NMOS transistors, a first source of a first NMOS transistor of the NMOS transistors connected to a first reference voltage source, a first gate and a first drain of the first NMOS transistor connected

to the output end of the level shift circuit, and a second gate and a second drain of a second NMOS transistor of the NMOS transistors connected to the output end of the negative charge pump;

a differential amplifier, whose first and second input ends are connected to a second reference voltage source and the output end of the level shift circuit respectively, for generating a compare signal by determining a voltage difference between the second output voltage and a voltage generated by the second voltage source; and a voltage-controlled oscillator connected between an output end of the differential amplifier and an input end of the negative charge pump.

[c11] 11.The regulated charge pump of claim 10, wherein the second voltage source is ground.

[c12] 12.The regulated charge pump of claim 10 further comprising:
a protection circuit, whose input end and output end are connected to the output end of the negative charge pump and wells of the NMOS transistors respectively, for generating a first protection voltage at the output end of the protection circuit by determining the first output voltage.

[c13] 13.The regulated charge pump of claim 12, wherein the

protection circuit comprises:

a switch, whose first and second ends are connected to the output end of the protection circuit and the first protection voltage respectively; and

a voltage detection circuit connected to the switch and to the output end of the negative charge pump for controlling the switch by determining the first output voltage.

[c14] 14.The regulated charge pump of claim 13, wherein when the voltage detection circuit detects that the first output voltage is higher than a threshold voltage, the switch is closed and transmits the first protection voltage to the wells of the NMOS transistors.

[c15] 15.The regulated charge pump of claim 10 further comprising:

a protection circuit, whose input end, first, and second output ends are connected to the output end of the negative charge pump, a first well of the first NMOS, and wells of remaining NMOS transistors respectively, for generating first and second protection voltages at first and second output ends of the protection circuit respectively by determining the first output voltage.

[c16] 16.The regulated charge pump of claim 15, wherein the first protection voltage is lower than the second protection voltage.

- [c17] 17. The regulated charge pump of claim 15, wherein the protection circuit comprises:
- a switch, whose first, second, third, and fourth ends are connected to a first output end of the protection circuit, the first protection voltage, a second output end of the protection circuit, and the second protection voltage respectively; and
 - a voltage detection circuit connected to the switch and to the output end of the negative charge pump for controlling the switch by determining the first output voltage.
- [c18] 18. The regulated charge pump of claim 17, wherein when the voltage detection circuit detects that the first output voltage is higher than a threshold voltage, the switch is closed and transmits the first and second protection voltages to the first well of the first NMOS transistor and the wells of the remaining NMOS transistors respectively.